Description

A METHOD OF PLANNING AND MANUFACTURING AN LNG STORAGE TANK OR THE LIKE AND AN ALUMINIUM LNG STORAGE TANK MANUFACTURED USING THE METHOD

[1] The present invention relates to a method of manufacturing an LNG storage tank according to the preamble of claim 1 and an LNG storage tank, in which the method has been applied, according to the preamble of claim 7.

[2] In order to store and transport liquefied natural gas in ships, membrane tanks supported by the hull structure of the ship or self-supported spherical or prismatic tanks made of aluminium, stainless steel or 9% nickel steel, are usually used. In LNG receiving terminal, the usual preference is for various types and different sizes of usually cylindrical self-supported tanks or membrane tanks made of 9% nickel steel or stainless steel. Self-supported nickel steel tanks are heavy, so there's a tendency to optimise the structures by using thinner structures, whereby weldability is a problem, especially weldng shrinkage. In practice, it is necessary to use internal support structures in a prismatic tank, making the structure complicated and adding costs. When applying known solutions, a large part of the work will have to be carried out on-site at the installation site, making the manufacturing more difficult, increasing both completion time and manufacturing costs.

[3] Due to the very low temperatures of cryogenic liquefied gases, such as typically ethylene (LEG) -103°C or natural gas (LNG) -163°C, the dimensioning accuracy and quality demands of the joints are emphasised in the manufacture of the tank. The manufacture of the tank consists of a number of cutting, assembly and welding steps for various parts. Each cutting and assembly step has its own specific accuracy due to its work process. The accumulation of form errors has been found to start already at the form deviations of the materials. Dimension deviations are cumulatively formed in each work step. The accuracy of the cutting work can be improved to a certain degree by carefully and regularly servicing the machines and by monitoring their quality development, but the result depends on the used cutting method in addition to the age and design of the machines. In welding, the input of heat caused by arc welding causes shrinkage, which cause considerable dimension accuracy errors and transformations with the methods currently in use and especially in aluminium structures, the heat conductivity of which is great.

[4] The level deviations formed in previous work steps are removed in transformation rectification work. The rectification in steel structures is based on causing shrinkage and performed using heat. The properties of the materials used for demanding ap-

plications, such as LNG tanks, can deteriorate in heat treatment, whereby heat rectification is either totally forbidden or it may be used only in carefully determined conditions. The caused local shrinkage have a shrinking effect on the whole assembly and cause an uncontrolled loss of dimension accuracy and thereby considerable error costs. The transformations of aluminium structures are multifold in comparison with steel and straightening is difficult. All in all, improving the dimension accuracy has been found to be the largest single method of improving productivity and profitability.

[5] The aim of the invention is to produce a new, improved method of producing a tank for storing liquefied natural gas (LNG) or other such cryogenic medium, in which method the savings potential related to error costs as well as clarity and simplicity of structures has been taken into account so that it allows an advantageous assembly, considerably reducing the total lead time of the manufacture and industrial production having less expensive costs. The aim is to provide a manufacturing method suitable specially for large tanks, the volume of which can, for example, be 100.000 m3 or more.

[6] The aim of the invention can be achieved as disclosed in claim 1 and as described in more detail in other claims. According to the invention, the tank is produced at least mainly from prefabricated construction elements of few different types so that plane elements to be used as cover panels for the tank are produced, the elements being manufactured by mechanically extruding profile elements comprising a plane part and a stiffening part and which are welded to each other by their plane parts by friction welding, the plane elements thus produced being provided with longitudinal and/or transverse stiffeners manufactured by mechanically extruding profile elements which are welded to each other by friction welding and that the plane elements thus produced are connected to each other and/or to separately manufactured edge and/or corner elements as self-supporting volume units having at least four sides.

[7] In a method according to the invention the prefabricated basic parts are thus produced by mechanically extruding as far as possible, whereby the dimensional accuracy of the parts is optimised. Thus, friction welding can be used for connecting these into larger assemblies as extensively as possible, whereby also the input of heat and the heat tensions caused thereby can be effectively minimised.

[8] Due to its modularity, the tank type according to the invention is excellently suitable for a factory-like manufacturing process. As the parts are assembled in steps into larger assemblies and further to volume units of desired size to be installed into each other, they can be manufactured already at the factory in better, more controlled conditions. This is suitable for reducing costs and improving the lead times of the manufacturing.

[9] By producing the construction units from aluminium or the like the weight of the

structures can be reduced, which makes the pieces easier to transport and essentially reduces the costs of a ready unit. According to preliminary dimensioning calculations a self-supporting aluminium tank of similar size is about 30 % lighter than a corresponding tank made from 9% nickel steel or stainless steel.

[10] One or more volume units are chosen for forming a tank of desired size, the units being arranged one after the other and attached to each other.

[11] In practice, the prefabricated construction elements are accurately machined to correct dimensions and the ends of the plane elements and the profiles are bevelled for forming a correct and accurate welding groove, preferably by machining with a shape cutter for achieving as great a dimensioning accuracy as possible.

[12] The extruded profile elements of the plane elements are preferably made symmetrical in relation to the normal plane of the plane portion and that their stiffening portion is T-formed in cross-section. Thus, the profile elements can preferably be used in any point of the construction. Additionally, the dimensions of the profile element are changed depending on the place the plane element is planned to be located at in the ready tank.

[13] Separate corner and edge elements are preferably made from rolled plate bent into the shape and dimensions of the desired radius.

[14] The advantages of the invention are most obvious in considerably large structures. Thus, a plane element used in the shell structure and splash bulkheads is dimensioned so that its size is about 16 x 16 metres, considering the machine and transport points of view.

[15] If volume units are connected to each other in order to produce a tank having a larger volume, a splash bulkhead produced from extruded profile using friction welding is placed between the units, the bulkhead comprising a number of openings connecting the adjacent volume units.

[16] The invention also relates to a aluminium tank or the like suitable for storing LNG or the like medium in very low temperatures, typically in the order of -163°C, the basic form of the tank corresponding to a rectangular prism. According to the invention, the tank is produced at least mainly from prefabricated structure elements of relatively few different types, the elements including plane elements to be used as shell elements of the tank produced by mechanically extruding aluminium profile elements or the like, the elements including a plane portion and a stiffening portion and which are welded to each other by their plane portions by using friction welding. The plane elements thus produced are provided with longitudinal and/or transverse stiffeners, produced by mechanically extruding aluminium profile elements or the like, welded to each other by using friction welding. Thus produced, the plane elements having stiffeners are connected to each other and/or to separately produced edge and/or corner elements as

self-supporting volume units having at least four sides.

[17] For forming a tank of desired size, one or more volume units are arranged one after the other and connected to each other. When the tank is formed of a number of prefabricated self-supporting volume units arranged one after the other, they are most preferably separated from each other by means of a splash bulkhead. The tank is additionally provided with means, for example with a tube tower known as such, for filling and emptying the tank.

[18] As far as the manufacture of the tank is concerned, it is preferable that the extruded profile elements of the plane elements are symmetrical in cross-section in relation to the normal plane of the plane part and that the stiffener part is T- or I-shaped in cross-section.

[19] In the following the invention is described by way of example and with reference to the appended schematic drawings, of which

[20] - figure 1 shows the manufacture and assembly of the basic elements of an LNG tank according to the invention,

[21] - figure 2 is a partial enlargement II of figure 1,

[22] - figure 3 is a partial enlargement III of figure 1, and

[23] - figure 4 shows assembling the LNG tank from a number of prefabricated volume units to a desired size.

[24] In the drawings, reference number 1 means profile elements produced by mechanically extruding from aluminium or the like, the elements including a plane part 1a and a stiffener part 1b. Reference number 2 means a plane element used as a shell panel of the tank on various sides thereof and produced by friction welding to each other a number of profile elements 1 as shown in figure 2.

[25] Reference number 4 means stiffeners installed longitudinally or transversely to the plane element as shown in figure 1, the stiffeners being as well produced by friction welding to each other profile elements 3 produced by mechanically extruding, as shown in figure 3. These profile elements can comprise various stiffening portions as well. Stiffeners can refer to vertical, horizontal or longitudinal stiffeners, depending on the installation place of the shell panels 2 having stiffeners 4 in the ready tank.

[26] Reference number 5 means the edge element and reference number 6 means the corner element. In practice, these are made from a rolled plate bent into the shape and dimensions of the desired radius.

[27] As can be seen in figures 1 and 4, volume units 7 are first assembled from the basic elements. One or more volume units 7 are then chosen for forming a tank of the desired size, the volume units being arranged one after the other and connected to each other. In case the tank comprises more volume units, a splash bulkhead 8 manufactured from extruded profile by using friction welding is installed between them, the bulkhead

comprising a number of holes 10 connecting the adjacent volume units. Preferably, the splash bulkhead is also provided with stiffeners.

[28] A volume unit 7 having five sides is located at either end of the tank, with a number of plane elements 2 being provided with the necessary edge and corner elements 5 and 6 for receiving the volume unit. Additionally, at least one of the volume units 7 is provided with means known as such, such as a tube tower 9 or a tube system with its included metering apparatuses and stairs, for filling and emptying the tank.

[29] As can be seen from figure 2, the extruded profile elements 1 of the plane elements are made symmetrical in relation to the normal plane of the plane portion 1a and their stiffening part 1b is additionally preferably T-shaped in cross section. Depending on the planned installation place in the ready tank of the plane element 2 to be manufactured, the dimensions of the profile element 1 can preferably be varied in the plane of the cross section, because the strength requirements of the different parts of the tank can correspondingly vary.

[30] It is obvious that a tank according to the invention can be used for storing cryogenic liquid, especially LNG, whether the tank be installed on a suitable fixed base or on a movable base, for example a tank to be located on a ship, a barge or the like.

[31] The invention is not limited to the embodiments described here, but a number of modifications thereof can be conceived of within the scope of the appended claims.